

GAS-TO-LIQUIDS AND HYDROGEN PRODUCTION APPLICABLE TO OFFSHORE ENVIRONMENTS



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"Futuristic Energy Production Schemes in the OCS"

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Our Current Situation

- Our National Security is threatened by increasing dependence on imported petroleum from unstable world regions
- Experts predict world oil production will peak sometime this century
- Transportation is a major contributor to regional air pollution and ultra clean fuels are mitigators that offer improved public health
- Transportation is responsible for one-third of U.S. greenhouse gas emissions
- Affordable transportation is essential for our continued economic prosperity

Fossil Energy's Fuel Mission

Ensure Adequate Domestic Alternate-Source Transportation Fuels

- **Create mid- to long-term options for producing clean fuels for transportation and other end-use sectors from alternate domestic fossil resources, such as coal and natural gas**
- **Modify existing and develop new infrastructure suitable for transporting, storing, and distributing hydrogen from fossil resources for domestic transportation markets**

Why Gas-to-Liquids (GTL) and Hydrogen?



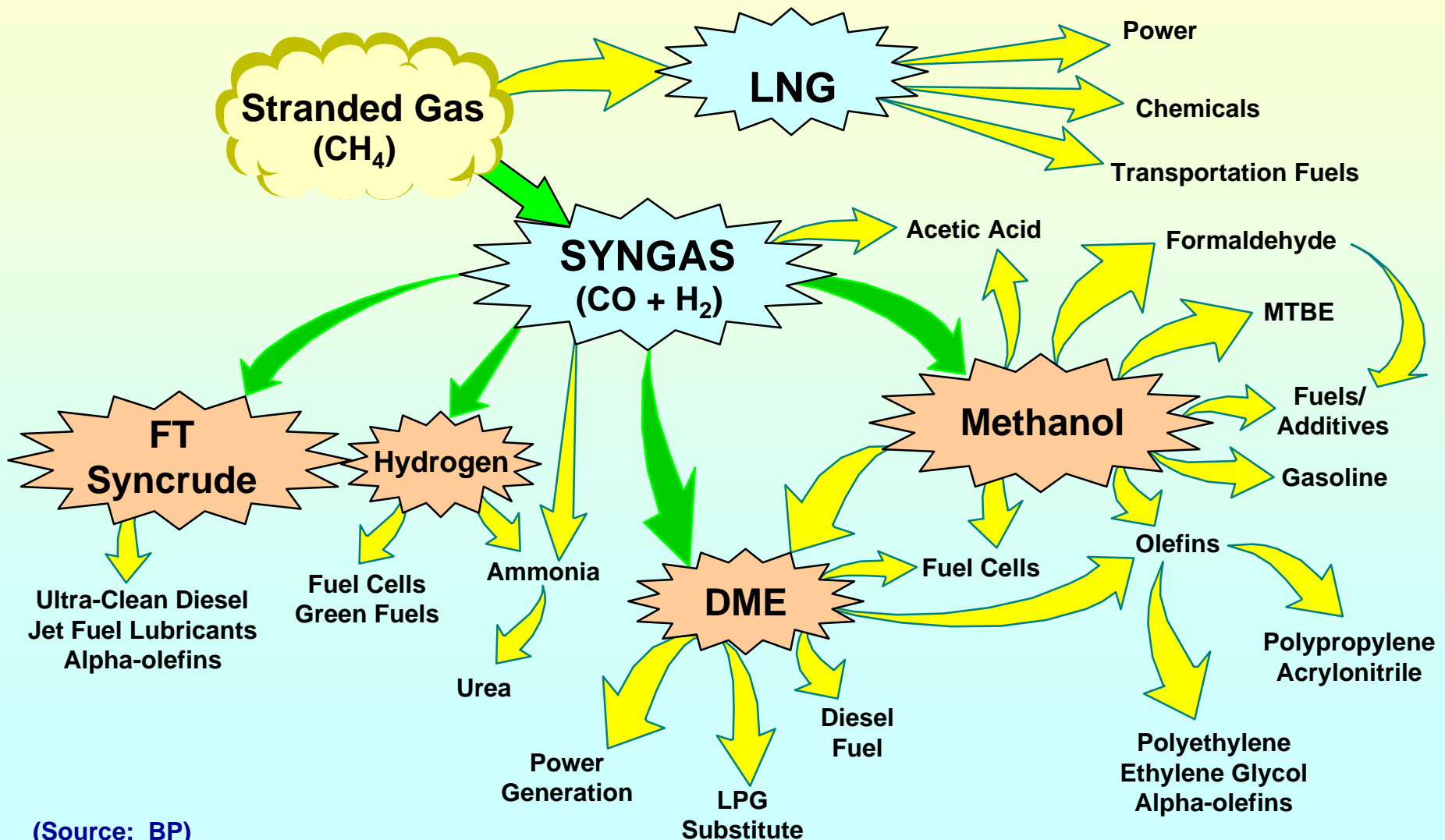
- Advanced GTL technologies will allow remote and deep gas to be converted to transportable liquid fuels and petrochemicals
- Hydrogen has the potential to reduce our dependence on petroleum imports and reduce pollution and greenhouse gas emissions

Why LNG?



- LNG technologies allow remote gas to be converted to a transportable liquid
- Advanced LNG technologies will allow this to be done more efficiently and economically and on smaller scale
- LNG is a resource for generation of clean electric power, a source of chemicals, and a transportation fuel

GTL, Hydrogen, and LNG Technologies Allow “Stranded Gas” Monetization Through Its Use in Power, Chemicals and Transportation Fuels

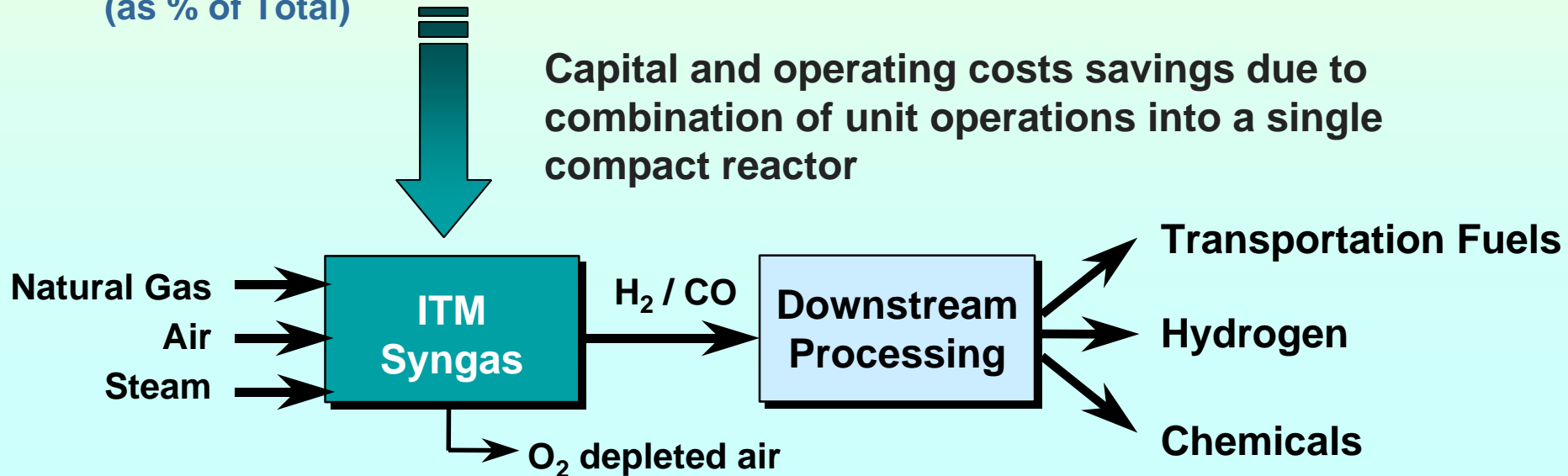
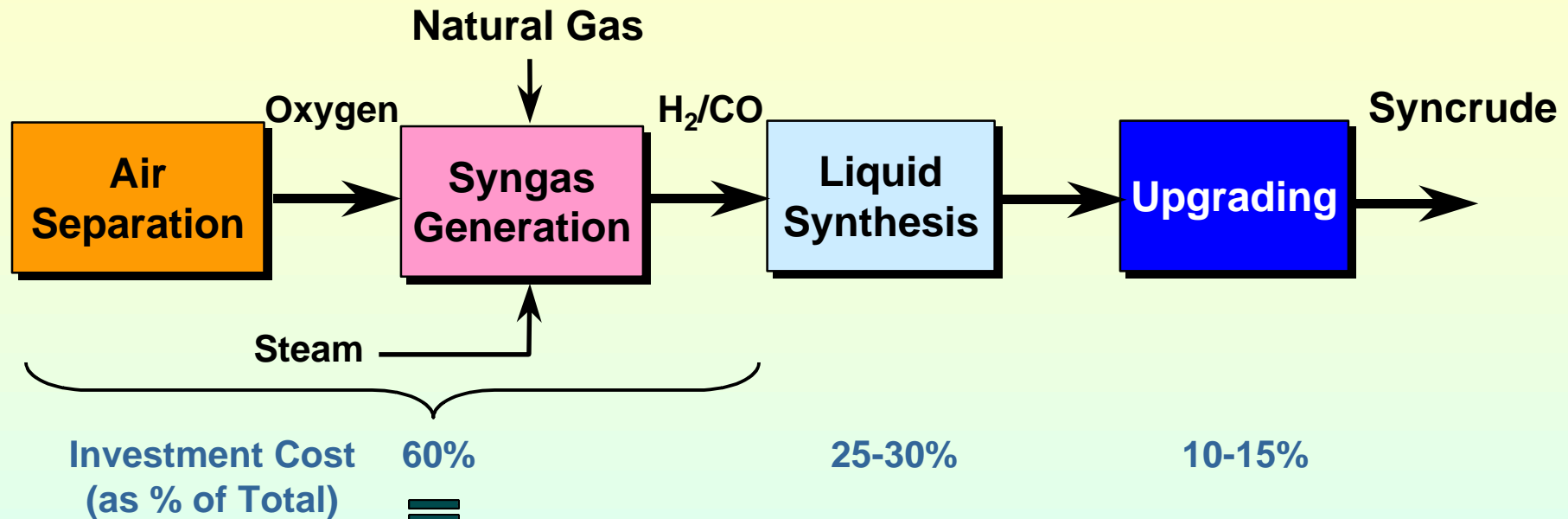


(Source: BP)

GTL is a Clean Fuels Strategy

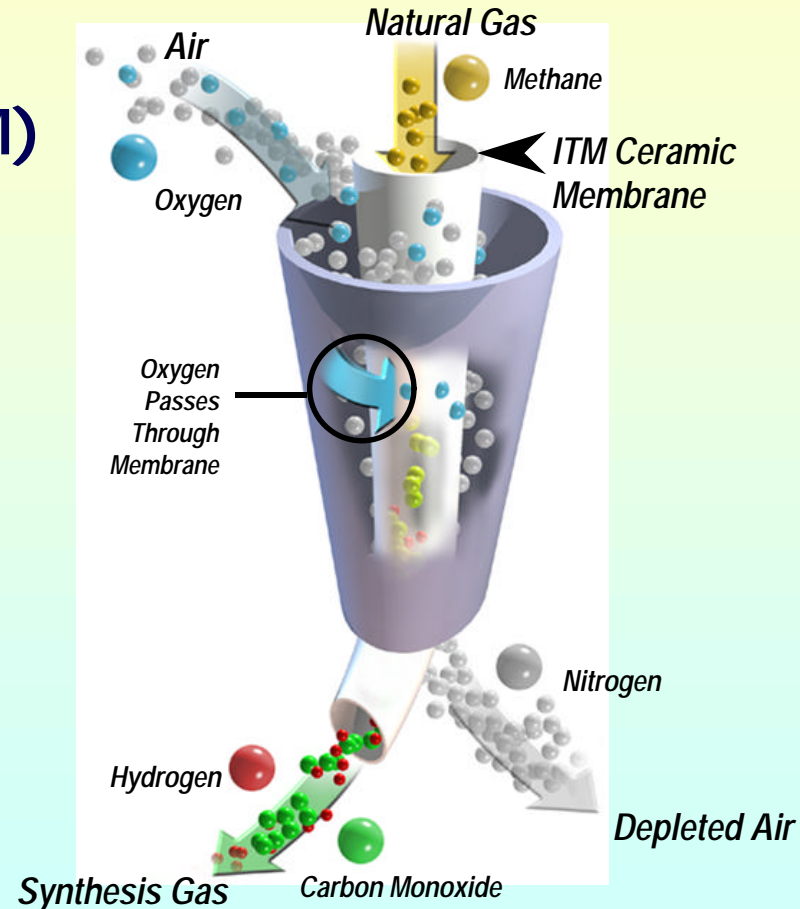
- Emissions performance of synthesis gas-derived diesel fuels is superior to petroleum diesel fuels
- Emissions reduction relative to low sulfur petroleum diesel:
 - Hydrocarbons 41-46%
 - CO 45-47%
 - NO_x 9%
 - Particulates 27-32%
- Emissions reduction relative to low sulfur/low aromatics petroleum diesel:
 - Hydrocarbons 25-31%
 - CO 34-38%
 - NO_x 5%
 - Particulates 23-29%

Conceptual ITM Syngas Process



ITM Syngas: Revolutionary Platform Technology

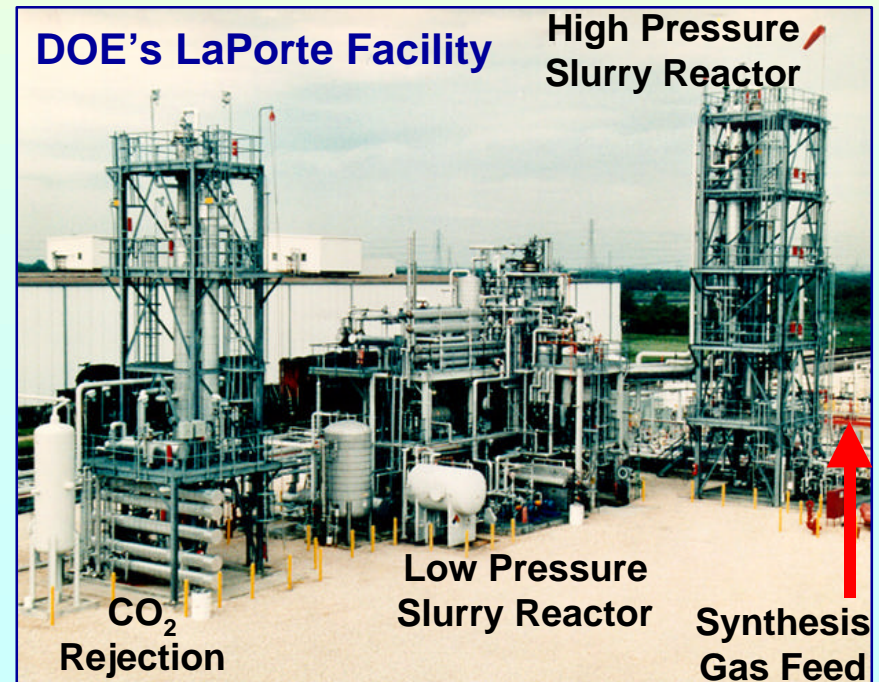
- **Ion Transport Membranes (ITM)**
 - Non-porous multi-component ceramic membranes
 - High oxygen flux
 - High selectivity for oxygen
- **Platform technology leading to numerous applications**
 - Transportation fuels
 - Hydrogen
 - Chemicals



Operating Temperature 750°C to 1000°C
Operating Pressure 450 PSIA

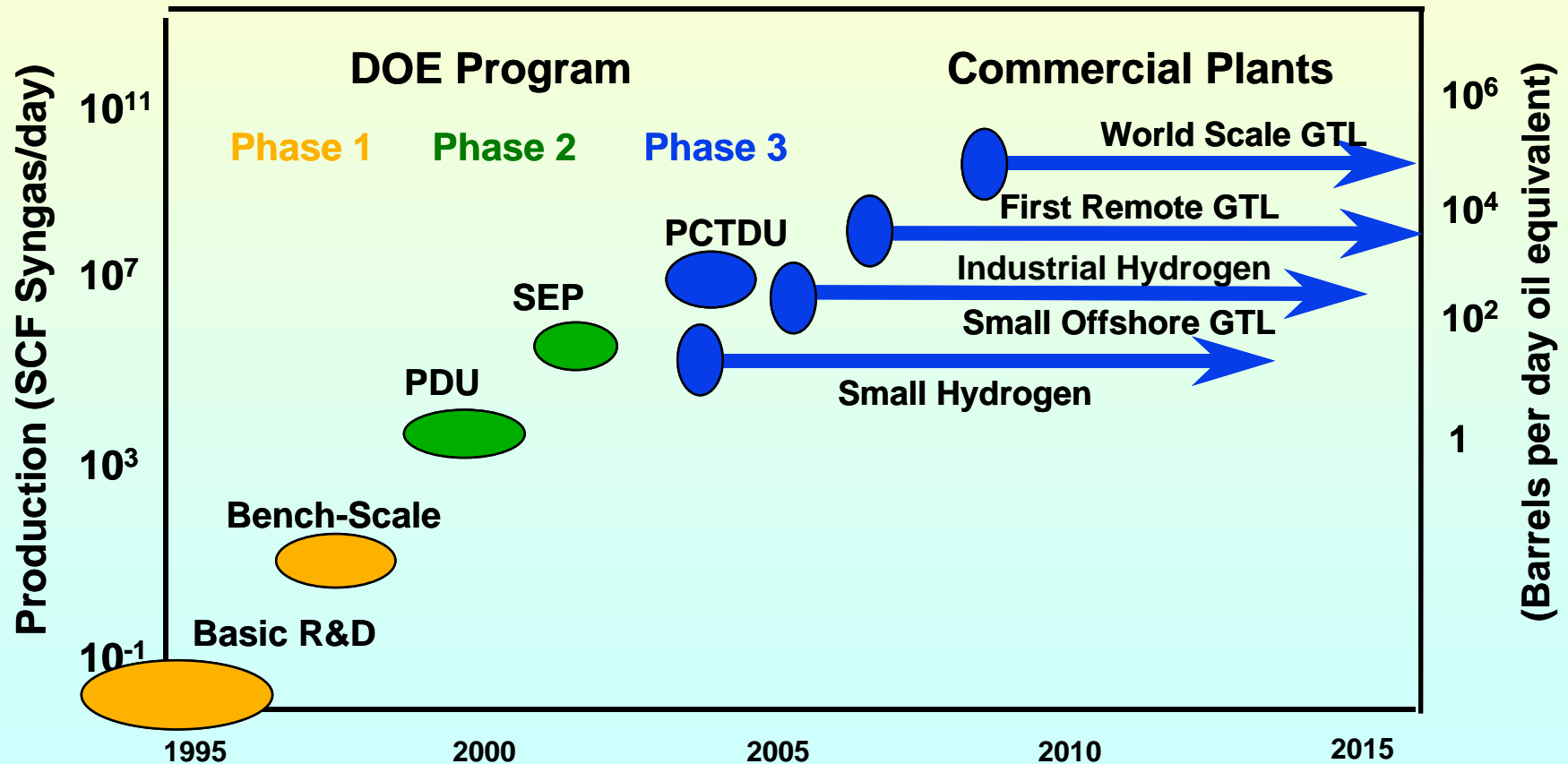
ITM Syngas for Transportation Fuels and Chemicals

- **50 MMSCFD natural gas feed**
 - Nominal 200 MMSCFD syngas or 6,000 bbl/day syncrude
 - Offshore or small land-based GTL
 - 30 to 35 % capital cost savings compared to conventional technology (O_2 - blown ATR)
- **450 MMSCFD natural gas feed**
 - Nominal 1800 MMSCFD syngas or 54,000 bbl/day syncrude
 - Large land-based GTL (3 trains)
 - Confirmed scalability of equipment and economics



ITM Syngas Development Plan

Currently in Phase 2 of three phase
8.5 year development program



Fuels Program: Ultra Clean Transportation Fuels Projects

- **Praxair**
 - Ceramic membrane reactor to separate air and partially oxidize methane to synthesis gas
- **ICRC/Syntroleum**
 - Concept to produce synthesis gas from natural gas to produce Fischer-Tropsch fuels in “small footprint plant”
- **Conoco**
 - Concept to produce synthesis gas from natural gas for less costly Fischer-Tropsch and other fuels using a novel concept to produce synthesis gas
- **Envires**
 - Novel process to cheaply convert fossil feedstocks to separate hydrogen and carbon monoxide. The hydrogen to be used in refineries

FPSO* Layout: ITM Syngas Achieves Up to 40% Footprint Reduction Compared to Conventional Technology

